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Techniques in education must be developed which are in keeping with technological advance. A doctrine of "concurrency" is necessary so that education will coincide with new developments in society. A system approach in education can do this by providing a conceptual framework for planning, orderly consideration of functions and resources, and a phased and ordered sequence leading to the accomplishment of specified and operationally defined achievements. A systems approach should provide a way to check relation of performance to factors required by economy. The latter requires some national control of the training and education developed through the system. The proposed subsystems to the overall system will eliminate such existing problems as surplus skilled unemployment, balance of unemployment throughout the country, and disparity in achievement caused by individual differences. From established skills and prognosis of future employment needs, an assessment can be made of the probable content to be taught. Corresponding curriculum changes must keep pace with the predicted needs and can be computer diagnosed. A specific training period will rely on computer analysis of the functions a student is directed toward. A particular student's qualifications will be computer assessed to narrow fields for his choice of career. A bibliography is included.

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A SYSTEM APPROACH FOR EDUCATION

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by

Donald K. Stewart

July 23, 1963

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PREFACE

During the last two years, many of the ideas that are presented in this paper were conceived but never written down. In reading the various sources that I consulted for additional information, I was surprised and at times gratified to find that other people had the same or similar ideas. The greatest values for me in writing this paper were to be more or less forced to put these ideas into writing (satisfying the requirements of the course), to find verification for my ideas, and in finding many of the missing links needed to build a system from my ideas in the lectures, films, books, etc. associated with the course--conducted by Dr. James Finn. I am sure that there are many details left unexplained, but as time goes by I hope to expand, adapt, and consolidate this paper again and again in an attempt to arrive at a practical solution for the educational crisis.

D.K.S.

A SYSTEM APPROACH FOR EDUCATION

The last fifty years has seen the emergence, due to modern technology, of many new human tasks which have demanded new kinds of complex skills, i.e., operating new machinery, etc. Dr. Ralph Tyler has stated that the opportunities are closing rapidly for people to engage in gainful employment with only a limited education, for the expansion in employment has been largely if not wholly in fields that require greater educational background. He also states that we can no longer say to a person reaching the 10th grade or the end of compulsary education, that if he drops out of school he can find a job--because there aren't that many available. From 1947 to 1957, ninety per cent of the increased employment was in nonproduction workers.(10) The shortage of trained professional and technical people may have already seriously affected our national growth by creating limitations. A survey of 140,000 unemployed people in Chicago revealed that almost two-thirds of them had never completed high school. (10) The increased educational requirements for new workers can not be met by most of the available workers; vocational and technical training has been inadequate; counseling and guidance has been worse than inadequate: and the retraining facilities are generally lacking. (10) Simon Ramo has said that this rapid and potentially dislocating scientific advance can be

expected to heighten the coming crisis in education. There has been about a 40 year time delay between the detection of errors in the "real world" caused by improper education and the change in the academic environment. (11) There are times when an existing system is beyond repair and continued modifications are unable to satisfy the demands for efficiency or a more effective product, but Dr. Henry Brickell has stated that our greatest barrier in improving education will be our own loyalty to the inadequate organization and arrangements which exist today. Leonard Silvern writes that it is time to either modify the existing system or to invent a new one and that a new system would probably be the better process. In agreement, Ramo states that our hope for attaining any kind of stability in the technical world ahead must rest on our ability to look ahead, to understand the world, and to adjust to it by developing a technique of education which is in keeping with the world ahead.

System developers in the past have felt that if the hardware in the system can be made to operate, somehow the necessary human beings with the right characteristics can be found and fitted into the system. But the rapid development of machines demand more and more organization of the human components of systems and the practical outputs of better system performance in both men and machines are too important to ignore. For this reason the armed forces are and have been training people for equipment that hasn't even been built yet; thus when machines are completed, trained personnel are ready to operate them. The strength of society is largely a function of the effectiveness with which its manpower resources are utilized within the systems which constitute it. Systems are developed to satisfy the needs and desires of society and

to facilitate man's control over his environment. Human engineers, scientists, etc. have directed a lot of effort toward the human component of future systems, recognizing the necessity of a "doctrine of concurrency", i.e., that the human components and the remainder of the system must be programmed to arrive at a man-mahine assembly point at the same moment in time. (2) Without this "doctrine of concurrency" in areas outside of the armed forces, we may reach a plateau in our progress; with it, we may have sort of a planned employment and a consequent continued increase in progress.

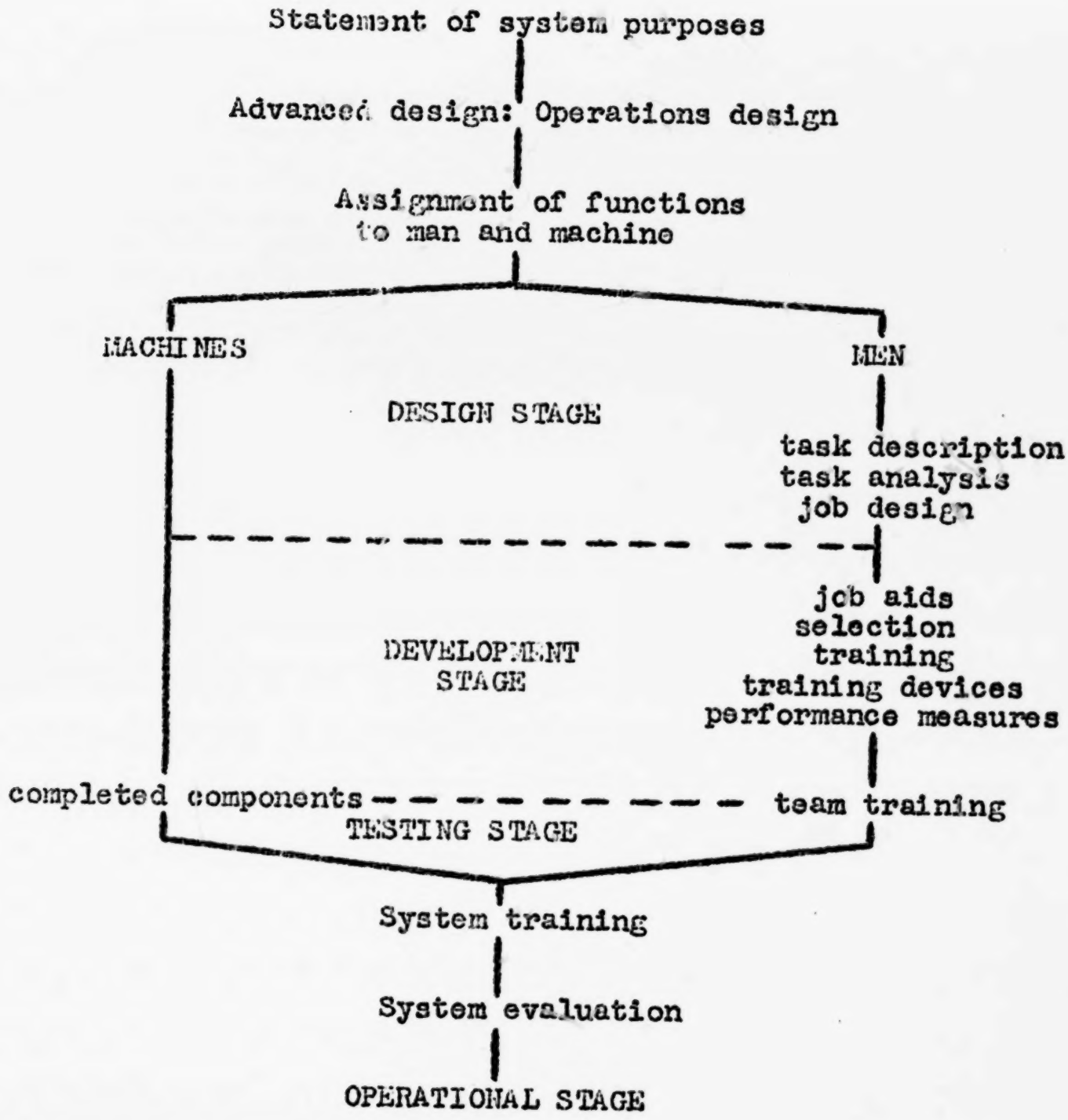


Figure 1 - System Development

John L. Kennedy has defined a man-machine system as an organization whose components are men and machines, working together to achieve a common goal and tied together by a communication network. He has also stated that the functions that men perform best are the non-routine, problem-solving, trouble-shooting, programming, inventing, goal seeking, and integrating; while the functions that machines perform best are extensions of human capabilities, such as seeing, hearing, moving rapidly, lifting, manipulating, memorizing, etc. As can be seen from Figure 1, once the goals or purposes of the system are defined, both kinds of system components--man and machine--must be planned from the very beginning with continued reference to these goals. The designers of the system must not only choose the most desirable characteristics of machines to perform functions which "fit together" to accomplish these goals; they need also to make similar kinds of decisions, throughout the development process, with respect to the characteristics of the men who become parts of the system.(2)

But what about the idea of a system approach in education? As early as 1956, Dr. James Finn wrote an editorial for Teaching Tools in which he stated that a system approach in education implied a total commitment. (3) Donald Bushnell wrote that he felt it would be self evident that a total systems concept would benefit education. (9) In a symposium at Stanford University in 1959, C. R. Carpenter was quoted as saying:

> A systems design for an educational enterprise would provide: a conceptual framework for planning, orderly consideration of functions and resources, including personnel and technical facilities..., the kinds and amount of resources needed, and a phased and ordered sequence of events leading to the accomplishment of specified and operationally defined achievements. A systems approach should provide a way of checking on the relation of performance of all components to factors of economy and should reveal any inadequacies of the several components, including the faults of timing and consequently of the entire system.

Whereas Figure 1 concerns a diagram for system development in general, with a few changes this diagram can fit the needs of education as it fits into the total system.

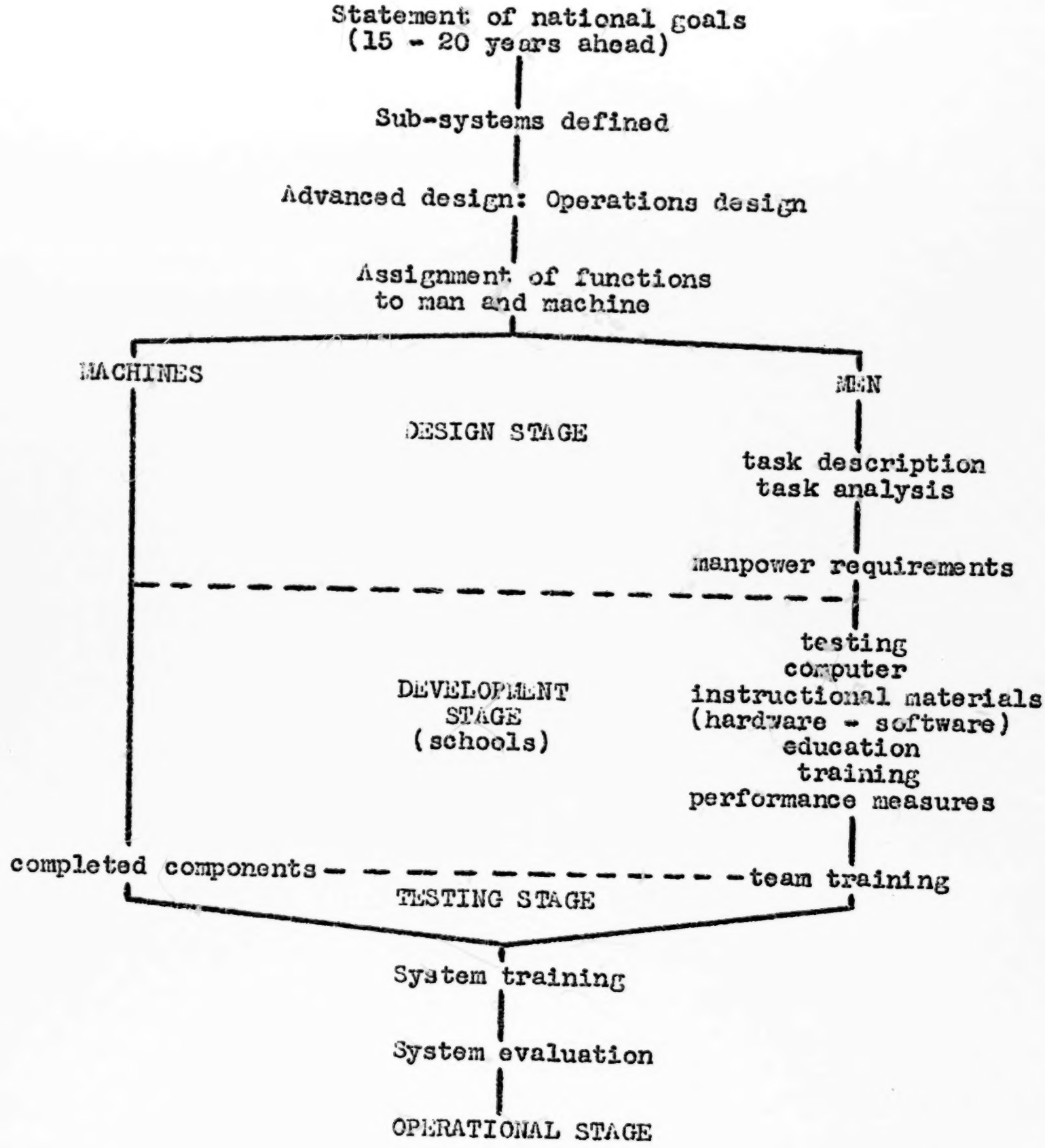


Figure 2 - System Development on a Total Basis Including Education

A proposed sequential listing of the requirements for using a system approach on a total basis including education are as follows:

(a) Statement of national goals, predicted needs, etc. for 15 to 20 years in the future.

(b) Various sub-systems are defined.

(c) Each sub-system is analyzed and operationally designed.

(d) Assignment of all functions involved in all sub-systems to man and to machine.

(e) Machines - designed and developed concurrently with the the design and development of men (in a generic sense).

(f) The functions assigned to man are analyzed and described according to the tasks involved.

(g) The education and training necessary to develop the necessary manpower requirements for the tasks are defined.

(h) Batteries of aptitude, attitude, performance, etc. tests are given at the beginning of the education sequence and periodically throughout the education and training time.

(i) These results, plus manpower requirements, plus personal interviews, etc. are fed into a computer which will help direct the student during the education period and will reduce the decisions regarding vocational direction to a few options, of which one or more may be followed during the training period.

(j) For some tasks, it may be necessary to include team training in the development stage with simulation equipment. This may or may not be done in a school situation.

(k) Throughout the whole process, the educational and training functions have to be flexible and readily able to change in accordance to changes in national goals, total design, assignment of man functions, or in machine design and development. (internal feedback)

(l) The testing stage of man-machine systems

(m) Further training if necessary.

(n) Evaluation of the completed man-machine system in accordance with national needs and goals at that time.

(o) Operational stage.

(p) There has to be an external feedback to the system also (Figure 3).

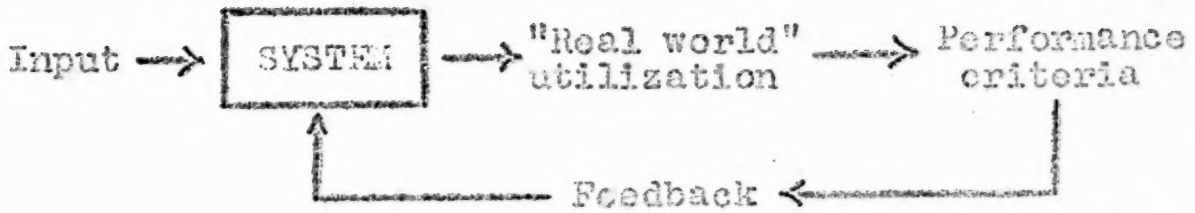


Figure 3 - External Feedback to the System

Charles Hoban has said that in one way or another, integration of the new media (system approach could be included) reduce the area of permissiveness and demand intense, prolonged, and detailed advanced planning. Under the concept of a total system, to be able to provide for mobility of humans, a philosophy of "interchangeability of parts" must be exercised to insure uniformity of the trained product. The development and exercise of these controls in terms of proficiency assessment constitutes an important administrative and research problem. (2) A re-examination of this last statement reveals a necessity for national controls on the education and training portion of the system. (This situation begins to sound like Harrison Brown's second most likely prediction about the future of the world: a completely controlled, collectivized industrial society.)

Besides the direct controls on the education and training periods in order to maintain uniformity of product, it will also be necessary to exercise indirect controls over the occupational directions of the people. It would be highly unlikely that the various kinds and degrees of abilities required to perform the operations demanded of the system will happen to be just those represented within the personnel pool of available manpower for the system. We must also consider that there is a limited amount of overall manpower available; consequently, the problem is to classify and select, to test and advise, to limit and direct

such that the needs of the man-machine system and the desires of men yield maximum congruence.

DEVELOPMENT STAGE

Now we have intograted the education and training periods into the total system, but how about the the education and training periods as a sub-system. What happens inside this sub-system? First let us look at some of the problems existing today that the proposed sub-system will hopefully eliminate.

1) The unskilled unemployed.

2) The surplus skilled unemployed.

3) The imbalance of certain skilled unemployed; high in one part of the country, low in another.

4) High school dropouts.

5) Disparity in achievement caused by individual differences.

6) If programed instruction is used and some students finish their programs early, what then?

7) Anxiety caused by uncertainty about the future as regards finding a job.

8) The potential 16 - 18 year old college graduate.

There seems to be a general agreement that the overall function of the "Development Stage" or "School Stage" is to prepare people for their performances in their adult roles. This assumes that we have an agreement on the meaning for adult. I would rather define the function of this period as the time to prepare people to perform their roles in the total system that were more or less predicted before they even started the school stage. At this point, I would also like to define my meaning for "education" and "training" as they will be used in this paper.

Education: general program of instruction that will fit people for many sub-systems in our society, and is evaluated by the "growth" of the individual.

Training: specific program of instruction by which individuals learn knowledges, skills and attitudes, not previously in their repertories and which will fit them to function as a human component, filling a particular job, in a system. It is evaluated by the person's contribution to the system.

Since under the proposed system, everyone is more or less working toward a specific task function, then each person will go through a phase of education and training; education first, training last. When I refer to a "school", "education", or "training", I am not referring to any specific physical plant, i.e., school building, etc. This is a research problem to be mentioned later. I am also assuming that it is possible to list, describe, or define the content of "education" particularly as it may be affected by our culture.

Two other terms needing further definition are "task description" and "task analysis", because as a result of these two aspects of the system functions that have been assigned to men, we are able to set up the criteria for training and some parts of education;such that,as the years pass by and the general education becomes a more specific training process, personnel are graduating into the testing stage at the moment the machines of the system are completed.

Task Description: a description of the physical movements, skills, etc. that are observable as being part of the particular task.

Task Analysis: a description of the covert behavioral requirements that parallel the physical movements.

For the first time there is a growing body of knowledge concerning the characteristics of the future demands for labor and with the knowledge of the current supply available, educators can plan ahead. (10)

There is research going on now in Illinois studying the probable course of future technological development with the purpose to be able to translate these findings into future occupational needs.(10)

From the estimated skills and knowledge levels of these future tasks plus an assessment of the probable content of the repertories of the people to be trained and educated, our psychologists, scientists, educators, etc. should be able to set up the content to be presented during the development stage. Various study groups have already been working with particular subject areas with the following problem in mind:

> What should the curriculum be in light of
>
> (a) changes in the content itself,
>
> (b) and the kinds of ways that the content knowledge, and skills can be significant to a citizen of modern America? (4)

These study groups such as the Physical Science Study Committee, funded by the National Science Foundation, should be able to fit very well into the educational system developing texts and other instructional materials needed to fulfill the system requirements. (4) There have also been study groups formed to examine the proper balance of subjects for a given age grouping. (4)

In order to make the educational and training part of the system most effective and efficient, a number of basic problems have to be considered.

(1) Ordering, sequencing, and programing of information for effective learning.

(2) Determining the rates, difficulty, and semantic levels of information appropriate for the students to be taught.

(3) The heuristics of instruction, learning, problem solving, and remembering.

(4) Building into the system inherant interest and motivation for learning.

(5) Means and methods for compensating for the limitations of the system and control of necessary social and cultural forces to support it.

(6) Efficient phasing of learning cycles--acquisition, assimilation, transformation, and evaluation of learning gains.

(1 - 6 suggested by C. R. Carpenter)

(7) Subject material arranged in a hierarchical order, for the program as a whole and for each unit of instruction within the program.

(8) Presentation of theory in relation to the practical only when it will be of value in learning other material presented later or when the knowledge is needed in order for the person to perform their later function in adult life.

(9) Flexibility of the course outline to meet individual differences, i.e., sufficient horizontal development to keep the brightest student busy while on individual projects.

(10) The learner should be aware of the system and his present and future part in it, also he should know

(a) what he is to know--curriculum,

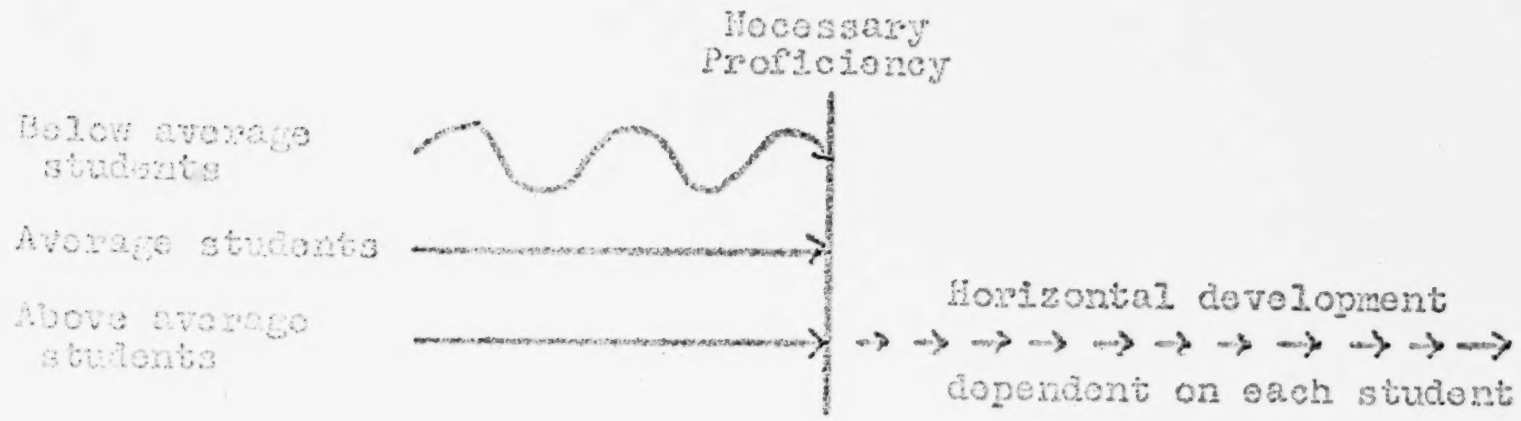
(b) why he should learn it--maturation,

(c) and how he should learn it--programming (2)

(11) Establishment of controls to maintain adherence to the educational and training objectives.

(12) All of these things to be done with the future in mind, not the present or the past.

For any given unit of information to be presented to a particular age group, variations caused by individual differences are taken care of in the following manner:



This type of treatment is carried out with each unit of information, such that the following characteristics can be observed:

(a) The curriculum is set up so that the average student will be able to complete his education and training at the desired time.

(b) The below average student is required to spend more time in his studies in order to maintain the necessary proficiency needed.

(c) The above average student will complete the required unit faster and will continue on in a horizontal development of this unit until such time as all students have reached at least the necessary proficiency.

(d) Grading or evaluation will not be based on the students proficiency in the required material (this is sort of a given), but the below average students' grade will be a function of the excess time needed for him to acquire the necessary proficiency and the above average students' grade will reflect the degree of horizontal development he attained before the average student completed the required material.

(e) These grades or scores are fed into the computer and along with other data mentioned in (h) and (i) on page 6 which help to determine the functional direction and also the distance to be traveled during the development stage.

(f) All students in a particular group start and end units together such that at the end of a certain number of units, i.e., one year; all of the students have covered the same vertical distance, but have vastly different sets of experiences (except for the average and below average student).

(g) Depending on the students' file in the computer, etc. and the functions the student is directed towards (in adult life), two to three years before the termination of their development period will be spent in "training". This may occur during the last stages of our so-called high school period or it may come later on.

(h) Instead of being faced with an almost unlimited number of future task positions for which the student knows practical none of the prerequisites or the operations, the computer will narrow the field down considerable, such that each student still has a choice of a task position to train for, but he will be able to decide on one out of two or three (knowing that he will be successful in any one of the choices presented)

(i) The whole curriculum will be programmed in such a manner that each unit of information will be presented by the media best suited for the content and objectives of the unit, i.e., TV, film, lecture, programed instruction, self study, field trips, demonstration, etc.

(j) The role of the teacher will be more and more of a diagnostician to whom the student turns when some obstacle to learning is encountered. Since many of these obstacles to learning may lie within the personality of the student, the teacher may also function as a therapist.

(k) An information retrieval system will be available and will improve the performance and efficiency of the administrator, counselor, teacher, and student by

1) organizing and displaying vast stores of current educational data needed to carry out their tasks,

2) collecting and organizing information appropriate to the user's needs,

3) being dynamic rather than passive, such that upon the input of information, it will seek out interested individuals and make the information available to them.

Upon completion of the development stage, the students are introduced to their task position and accompanying machine relationship. For a brief period, it will undoubtedly be necessary to continue the training period, but in a team situation. Team training is defined as any experience in which a team engages which results in a change of team functions, organization, or performance. The team functions that are referred to can be fulfilled by a variety of men, machines, work procedures, and work procedures. Individual training can be thought of as component training while team training would be considered as sub-system training. (2)

WHAT CAN BE DONE NOW: HOW TO START

Tyler has stated that the biggest problem standing in the way of progress for schools towards accomplishing the tasks expected of it, is the shortage of adequately prepared teachers. (4) Another factor is the inadequacy of the public's perception of the nature andsignificance of the educational job. (4) Schramm claims that

teachers colleges might be expected to take more leadership in the training of present and future teachers in the use of new media, i.e., programed instruction, TV, etc. Actually, Schramm states, there isn't even a general movement of teachers colleges to make use of programed instruction in their training programs. We should be training our teachers for the schools that they will be teaching in and for the technology that will be surrounding them. Tyler has mentioned that the teacher of 1920 only taught for the average of three years; whereas the teacher of today teaches for about fourteen years. (4) What teachers college today is really training their students such that they will be able to teach in 1975 or 1980 without being obsolete? This situation has got to be changed if we expect our nation to maintain its position as a world leader.

BIBLIOGRAPHY

1. Glaser, Robert and others. Training Research and Education, Pittsburgh. University of Pittsburgh Press, 1962.

2. Gagné, Robert M. and others. Psychological Principles in System Development, New York. Holt, Rinehart and Winston, 1963.

3. Heinich, Robert, "A System of Instructional Management". An unpublished paper, December, 1962.

4. New Teaching Aids for the American Classroom, a symposium report, U.S. Department of Health, Education, and Welfare, 1962.

5. Lumsdaine, A. A. and Robert Glaser. Teaching Machines and Programed Learning, National Education Association of the U. S., 1961.

6. Schramm, Wilbur. Programed Instruction: Today and Tomorrow, The Fund for the Advancement of Education, 1962.

7. The Use of Programed Instruction in U. S. Schools, The Center for Programed Instruction and the U. S. Department of Health, Education, and Welfare, 1962.

8. Hoban, Charles F., "The New Media and the School", Audio-Visual Communication Review. Vol. 10, No. 6, November-December, 1962.

9. Bushnell, Donald D.,"The role of the Computer in Future Instructional Systems", Audio-Visual Communication Review. Vol. 11, No. 2. Supplement 7, March-April, 1963.

10. Cassell, Frank. "Changing Manpower Needs", NEA Journal, April, 1962.

11. Silvern, Leonard. Systems Engineering in the Educational Environment. Hawthorne, California. Northrop Norair, March 1, 1963.